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DISABILITY & REHABILITATION

Physical Activity Correlates in People Living with HIV/AIDS: A Systematic Review of 45 Studies

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Abstract

Purpose: Understanding barriers and facilitators of physical activity participation in persons living with HIV/AIDS is an essential first step in order to devise effective interventions. The present review provides a systematic quantitative review of the physical activity correlates in people with HIV/AIDS.

Methods: Major electronic databases were searched till August 2016. Keywords included ‘physical activity’ or ‘exercise’ or ‘sports’ and ‘AIDS’ or ‘HIV’.

Results: Out of 55 correlates from 45 studies (N=13,167; mean age range=30.5-58.3years; 63.2% male) 5 consistent (i.e. reported in 4 or more studies) correlates were identified. Lower levels of physical activity were consistently associated with older age (6/10 studies), a lower educational level (6/7), a lower number of CD4 cells/µl (7/11), exposure to antiviral therapy (4/6) and the presence of lipodystrophy (4/4). Other important barriers were the presence of bodily pain (2/2), depression (3/3) and opportunistic infections (3/4). Facilitators were a higher cardiorespiratory fitness level (3/3), a higher self-efficacy (2/2), more perceived benefits (2/2) and a better health motivation (3/3).

Conclusions: The current review has elucidated that participation in physical activity by people with HIV/AIDS is associated with a range of complex factors which should be considered in rehabilitation programs.

Keywords: physical activity; exercise; physiotherapy; AIDS; HIV

Introduction

The Global Burden of Disease Expert Group estimated that approximately 30 million people were infected with HIV worldwide in 2013, the majority of whom reside in sub-Saharan Africa [1]. Life expectancy in those infected with HIV has improved significantly since the introduction of effective antiretroviral therapy. Between 1990 and 2013, antiviral therapy saved approximately 19 million life-years in the HIV-infected population [1]. Whilst the longevity in life expectancy has increased among people living with HIV/AIDS, people are tending to live with many more chronic diseases [2]. In people living with HIV/AIDS these chronic comorbidities develop earlier and more frequently than in non-HIV-infected counterparts [3]. The most prevalent comorbidities are cardiovascular diseases, chronic obstructive pulmonary disease, cancers, arthritis, osteoporosis, and liver disease [4]. Current dominant hypotheses link the increased incidence of these comorbidities to HIV-related chronic inflammation [5], adipose tissue abnormalities [6], side-effects of antiviral treatment [7, 8] and modifiable lifestyle factors, such as increased tobacco use [9] and decreased physical activity [10]. The disability caused by these chronic conditions may be exacerbated or alleviated by intrinsic (personal attributes) and extrinsic (social support, stigma) contextual factors and impacts also the mental health and quality of life of people living with HIV/AIDS [11].

Self-management strategies, such as physical activity and exercise can address disability and optimize mental and physical health outcomes for people living with HIV/AIDS. While physical activity can be defined here as any bodily movement produced by skeletal muscles that results in energy expenditure, exercise is a planned, structured, repetitive and purposive form of physical activity that aims to improve or maintain one or more components of physical fitness [12]. Regular physical activity is considered to contribute to an improved body composition, cardiorespiratory and muscular fitness, lower levels of depressive symptoms and an improved physical and mental health related quality of life [13, 14, 15, 16, 17, 18]. It is therefore strongly recommended that people living with HIV/AIDS augment their physical activity levels, while adequate information and awareness is spread among service users and health care professionals, and corresponding opportunities for physical activity are built and maintained [19].

Despite the observed physical and mental benefits, a large proportion of people living with HIV/AIDS are still not engaging in physical activity on a regular basis [10]. Understanding barriers and facilitators of participation in physical activity in people living with HIV/AIDS is an essential first step in order to devise effective physical activity interventions. Behavioral theories, such as the socio-ecological model [20] have shown to be useful in attempting to understand the factors which influence physical activity behavior in vulnerable populations [21, 22, 23, 24, 25]. Socio-ecological models posit that multiple relevant attributes influence health behavior. These include intrapersonal (demographic, biological, psychological, emotional and cognitive), interpersonal/cultural (e.g., social support), physical environment (e.g., distance to the facilities, financial costs, enjoyable scenery), and policy (laws, rules, regulations, codes) factors [20]. Qualitative research in people living with HIV/AIDS exploring the perceived barriers for physical activity participation indicated that physical exertion, lack of social support, time and financial constraints and the distance to facilities are considered the most important and reported barriers [26, 27, 28]. Also uncertainty about the future [28], avoiding stigma [29], adverse weather conditions and domestic abuse and crime [27] are reported in this population. People living with HIV/AIDS participating in physical activity programs recognized as well that engaging in regular physical activity could provide energy, improve the self-concept and sleeping quality, and increase physical fitness and mental health [27, 29]. In order to elaborate and confirm such qualitative findings, quantitative research which is able to identify potential correlates of actual physical activity levels in people living with HIV/AIDS is also needed. This information can then be used to target future physical activity interventions for people living with HIV/AIDS. A systematic review on physical activity correlates in people living with HIV/AIDS is however currently lacking. Systematic quantitative research of potential negative and positive correlates of physical activity will provide valuable information to implement physical activity in clinical practice and will inform future research. The present review therefore systematically evaluates published quantitative studies on correlates of physical activity in people living with HIV/AIDS. In addition to summarizing methods and results of these studies, gaps in the literature are identified and directions for future research are proposed.

Methods

This systematic review was conducted in accordance with the " Meta-Analyses and Systematic Reviews of Observational Studies" - guidelines [30].

Data sources and searches

Two independent reviewers performed an electronic search of the health-related databases PubMed, CINAHL and Embase until August 1st 2016. Manual searches were also conducted using the reference lists from identified articles. The medical subject headings used were 'physical activity' OR 'exercise' OR 'sports' AND 'HIV' OR 'AIDS' in the title, abstract or index term fields.

Eligibility Criteria

Inclusion criteria were as follows: (a) a diagnosis of HIV or AIDS irrespective of the assessment method used, (b) participants were at least 18 years of age, (c) studies contained quantitative research and had been published in a peer-reviewed journal, (d) the dependent variable was a measure of physical activity participation. No restriction was placed on the selection of the outcome measure or the language of the article. For cohort or intervention studies, only associations of physical activity participation with baseline data were included. We excluded articles if the dependent variable was aerobic fitness, physical activity intention, self-efficacy, or other intermediate (non-behavioral) measures because these variables are less direct indicators of actual physical activity behavior [12]. Also, case reports and expert opinions were excluded.

Data Collection

Two reviewers independently extracted data from the included studies using a predetermined form. The form captured data in 6 domains including (a) gender, (b) age (mean), (c) ethnicity (%White), (d) the quality of the physical activity measure, and (e) physical activity correlates. The following categories were used to code the quality of the physical activity measure: (a) self-report with poor, unknown or not reported reliability/validity in people with HIV, (b) self-report with reported and acceptable reliability/validity in persons with HIV, and (c) acceptable objective measurements for people with HIV. Objective measurements included motion sensors such as accelerometers and pedometers, combined heart rate and accelerometer devices and the doubly labeled water method [20]. The acceptability of the psychometric properties of measurement tools was assessed according to previous recommendations [31]. In accordance with previous physical activity correlates reviews [21, 22, 23, 32, 33, 34] the following potential physical activity correlate categories were included: (a) demographic, (b) biological, (c) psychological / cognitive / emotional, (d) behavioral attributes/skills, (e) social/cultural factors, (f) physical environment, and (g) policy factors. Variables were classified as ‘related’ or ‘not related’ to physical activity based on statistical significance, and the direction of association for related variables was identified. The detailed data tables were further analyzed (see § 2.4. and 2.5) to create tables that summarized the state of the literature on different variables.

Coding Associations with Physical Activity

A variety of statistical techniques were used to evaluate correlates, including uni-/ bivariate analyses, correlations, t-tests, and ANOVA. If both uni-/bivariate and multivariate tests were conducted, uni-/bivariate tests were reported for consistency across studies. The column 'related to physical activity' indicates, which studies reported significant associations between the variable and the physical activity measure. Direction of association is indicated with a '+' or '-'. The column 'unrelated to physical activity' indicates which studies reported non-significant associations between the variable and physical activity.

Summary Codes

A summary code for each variable was presented and calculated following previous recommendations [35, 36]. The summary code column contains a code to summarize the state of the literature for that variable. The percentages refer to the number of associations supporting the expected association divided by the total number of associations for the variable. In accordance with previous physical activity correlates reviews [21, 22, 23, 32, 33, 34], associations were coded with: '0' (0-33% of studies supporting association); '?' (34%-59% of studies supporting an association); or '+' or '-' (60%-100% of studies supporting an association). When correlates were reported in 4 or more studies the summary code for these correlates were considered as 'consistent' and coded with '++', '--' or '??' .

Differences in Number of Significant Correlates

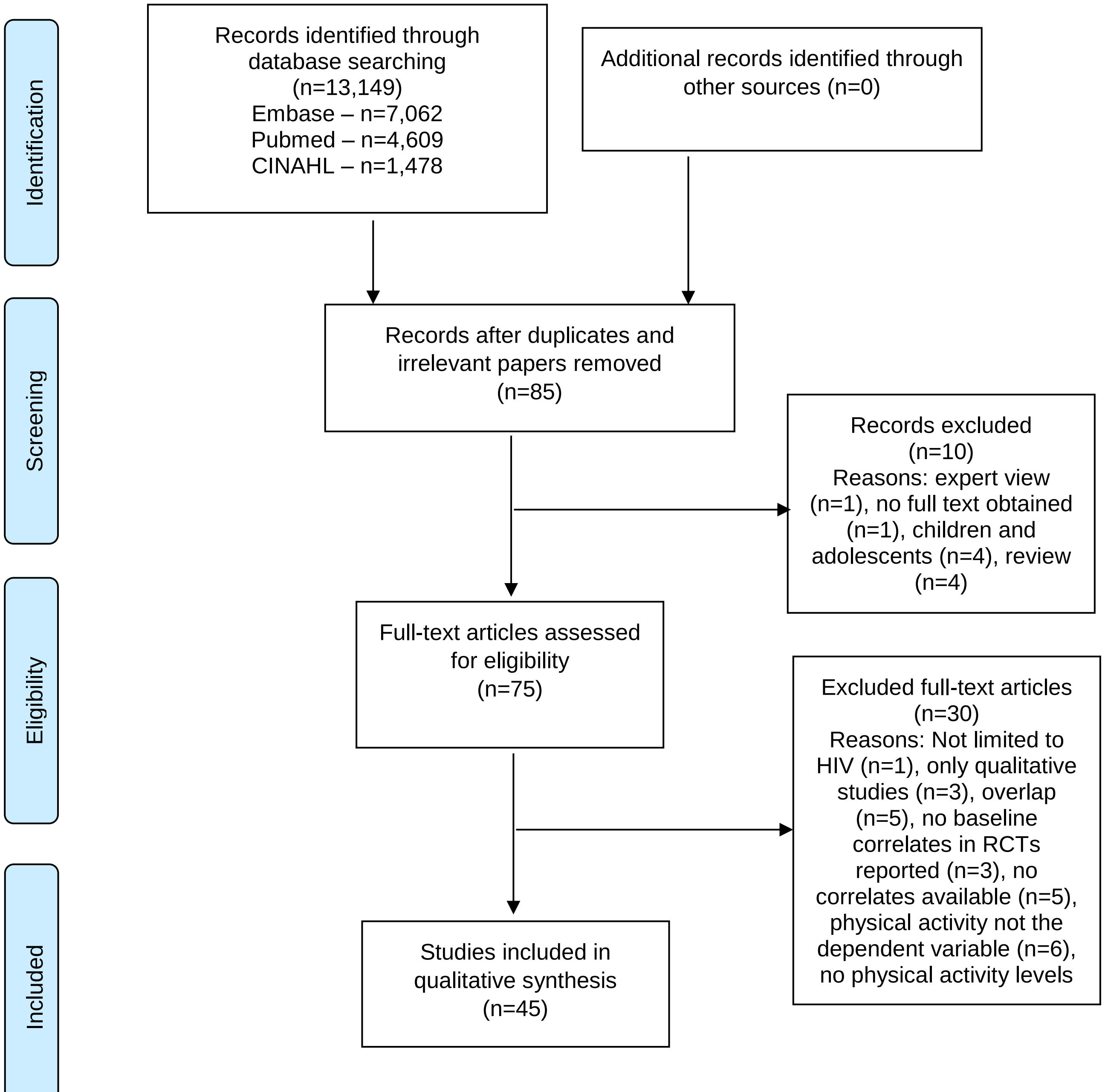
Using Fisher's exact tests, we explored differences in the number of significant correlates versus unrelated variables obtained via valid physical activity assessments versus assessments with unknown validity versus objective tools and between associations explored in studies with a sample size lower than versus equal to or larger than the median sample size.

Results

Study Selection

Out of 84 potentially eligible studies, 45 were included in this review [37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80]. The search strategy and reasons for exclusion are shown in Figure 1.

Figure 1. Flow Diagram of the Included and Excluded Studies



Participant and Study Characteristics

Across all 45 studies, a total of 13,176 people living with HIV/AIDS (mean age range=30.5-58.2years) were included in the analyses. Thirty-four studies had a cross-sectional design, ten were cohort studies and one was a randomized controlled trial. In 42 studies reporting on the gender distribution, the percentage of male participants was 63.2% (n=8,268/13,080). The sample size ranged from 21 to 2,864. The median sample size was 107. The majority of the studies were executed in the North-American (N=26), followed by South-America (N=6). There were 5 African and 5 European studies and one study was executed in Asia (China) and one in Australia. Concerning the quality of the physical activity measure, 27 studies were based on un-validated or unreliable self-report measures of physical activity or measures with unknown psychometric properties, 11 on validated and reliable self-report measures for people with HIV/AIDS and 7 studies used an objective measure of physical activity. Table 1 presents the characteristics of the included participants, the quality of physical activity assessments and the statistical analyses undertaken.

Table 1. Study Characteristics.

Nr	First author / year	Design	Country	Participants	PA measurement	Quality of PA Measurement	Statistical Analysis
1	Dirajlal-Fargo 2015 [80]	RCT	USA	72 (58♂); median age=45; 69% African American in the Rosuvastin group and 75 (57♂); median age=47; 67% African American in the placebo group	Adult AIDS Clinical Trials Group PA assessment	A	Regression analysis
2	Fazeli 2015 [79]	Cross-sectional	USA	100(88♂); mean age=58.2±6.5years; 82% White	IPAQ	B	Chi square analyses
3	Monroe 2015 [78]	Cross-sectional	USA	596♂; mean age=51years; 54% White, 17% African American, 29% Hispanic/other ; BMI=25.3	IPAQ	B	Adjusted quantile regression modeling
4	Olsen 2015 [77]	Cross-sectional	Ethiopia	116♂; mean age=37.6±8.6years; BMI=18.8±2.1; 232♂; mean age=30.5±7.8years; BMI=19.2±2.8	Accelerometer	C	Linear regression models
5	Ortega 2015 [76]	Cross-sectional	USA	21 (5♂) physically active with a mean age=44.1±17.2years, 73% African American and 27	self-reported historical PAQ	A	t-tests and multiple

				%White and 48(♂) sedentary with a mean age=40.1±15.6years, 75% African American and 25 %White	(previous year)		linear regression models
6	Webel 2015 [106]	Cross-sectional	USA	102(54♂); mean age=48±6.5years; 10% White, 84% African American, 6% Hispanic/other	Diary	A	t-tests
7	Erlandson 2014 [75]	Cross-sectional	USA	359 (305♂); mean age=52.0±5.2years; 74% White, 18% Hispanic	MLTPA	A	Spearman coefficients
8	Hsieh 2014 [74]	Cross-sectional	China	263 (200♂); mean age=38.4±9.8years; BMI=21.6±2.6; 94% Han Chinese	IPAQ	B	Logistic regression models
9	Justina 2014 [73]	Cross-sectional	Brazil	74 (45♂); mean age=44.3±9.2ears; 92% White	IPAQ	B	Regression analysis
10	Jaggers 2014 [72]	RCT	USA	63(31♂); mean age=48±11years	Accelerometer	C	ANOVA
11	Ramírez-Marrero 2014 [71]	Cross-sectional	Puerto Rico, USA	32 (13♂) Hispanics with lipodystrophy mean age=50.3±1.2 years; BMI=29.0±0.8 and 28 (15♂) Hispanics without lipodystrophy mean age=48.1±1.3years; BMI=26.4±1.4	Accelerometer	C	ANOVA

Table 1. Continued.

Nr	First author / year	Design	Country	Participants	PA Measurement	Quality of PA Measurement	Statistical Analysis
12	Raso 2014 [70]	Cross-sectional	Brazil	39♂; mean age=40.6±1.4years; BMI=24.8±0.6	IPAQ	B	Univariate regression models
13	Blashill 2013 [69]	Cohort	USA	860♂; mean age=43.8±9.9years; 80% White, 10% African American, 2% Asian, 8% other	Lipid Research Clinics PA questionnaire	A	Linear mixed effects modeling
14	Dufour 2013 [68]	Cross-sectional	USA	335(249♂); mean age=47.7±10.5 years; 51.3% White	Self-report exercise in the past 72h	A	T-tests and chi-square tests
15	Edward 2013 [67]	Cross-sectional	Nigeria	265(86♂); mean age=38.7±8.7 years	STEP-wise approach to Surveillance	A	Chi-square tests
16	Frantz 2013 [66]	Cross-sectional	South-Africa	407 (93♂); mean age=38.8±8.9years	Sub-Saharan African Activity	A	Chi-square tests

Nr	First author / year [Ref nr]	Design	Country	Participants	PA Measurement	Quality of PA Measurement	Statistical Analysis
17	de Bruin 2012 [65]	Cohort	The Netherlands	499 (245♂); mean age=44.3±10.0years; BMI=26.5±4.9	Questionnaire Having 30 min exercise 2 days / week.	A	Logistic regression models
18	Fillipas 2012 [64]	Cohort	Australia	80 outpatients, aged ≥18years	IPAQ	B	
19	Alencastro 2011 [63]	Cross-sectional	Brazil	1,240 (628♂); mean age=38.6±10.1years; BMI=24.9±4.4; 57.3% White	IPAQ	B	ANOVA
20	Kyser 2011 [62]	Cohort	USA	528 (410♂); median age=41years; 60% White, 28% African American, 12% Hispanic / Other	computer-assisted self-interview	A	
21	Segatto 2011 [61]	Cross-sectional	Brazil	42 (23♂); age range=31–59 years	IPAQ	B	Chi-square tests
22	Muronya 2011 [60]	Cross-sectional	Malawi	174 (67♂); mean age=40.8years	STEP-wise approach to Surveillance	A	Odds ratios
23	Bonfanti 2010 [59]	Cohort	Italy	292 (219♂); median age=37years; 86.2% White	Unknown: yes versus no	A	Univariate analysis

Table 1. Continued.

Nr	First author / year [Ref nr]	Design	Country	Participants	PA Measurement	Quality of PA Measurement	Statistical Analysis
24	Lo Re 2009 [58]	Cross-sectional	USA	1,237 (765♂); median age=43years	mild [<4h/week, intensive [≥ h /week]	A	Chi-square tests
25	Allard 2008 [57]	Cross-sectional	Canada	65♂; mean age=47.0±0.9years; BMI=26.5±0.4; 81.5% White, 10.8% African descents, 7.7% Asian descents	Activity logs	A	Mann-Whitney U-test
26	Basta 2008 [56]	Cross-sectional	USA	208 (181♂); mean age=42.6±7.1years; 84.6% African American or Black	IPAQ	B	
27	Kinsey 2008 [55]	Cross-sectional	South-Africa	186 (46♂ with a mean age=36±7years and 140♀ with a mean age=35±8years)	Combination MAQ, MLTPA and Baecke PAQ	A	Spearman's correlations / Mann-Whitney U-test

28	Kowal 2008 [54]	Cross-sectional	Canada	97 (81♂); mean age=39.4±8.7years; 71% White, 12% African, 4% Hispanic, 2% Haitian, 2% Aboriginal, 8% Other	Self-reported frequencies of exercising	A	Regression analysis
29	Littlewood 2008 [53]	Cross-sectional	USA	221 (124♂); mean age=40 years; 42% African-American, 46% White, 4% Native American, 4% Asian/Pacific Islander, 4% Other	Self-reported frequencies of exercising	A	Pearson correlation coefficients, ANOVA
30	Ramírez-Marrero 2008 [52]	Cross-sectional	Puerto Rico, USA	58 (35♂); mean age=46.5±8.8years; BMI=26.8±5.3	Accelerometer	C	Independent t-test
31	Florindo 2007 [51]	Cross-sectional	Brazil	230 (169♂); age range=20-59 years	Baecke PA questionnaire	B	Regression analysis
32	Florindo 2006 [50]	Cross-sectional	Brazil	30; mean age=37.2 years	Baecke PA questionnaire	B	Pearson correlation coefficients
33	Howard 2006 [49]	Cohort	USA	364♂; median age=54years; 61% African American, 24% Hispanic, 12% White, 4% Other	At least moderate PA ≥20 min >1 day per week	A	Regression analysis

Table 1. Continued.

Nr	First author / year [Ref nr]	Design	Country	Participants	PA Measurement	Quality of PA Measurement	Statistical Analysis
34	Jacobson 2006 [48]	Cohort	USA	342 (249♂) highly active antiviral therapy users with a mean age=42±7years, with 58% White, 31% African American, 11% Hispanic and 135 (97♂) non-highly active antiviral therapy users with a mean age=44±7years, with 44% White, 44% African American, 12% Hispanic	PA recall last 7 days	A	Cox proportional hazards
35	Salyer 2006 [47]	Cross-sectional	USA	95 (79♂); mean age=41.3±8.4years	Self-report days / week 30 min moderate PA	A	Factorial between-subjects ANOVA
36	Smit 2006 [46]	Cohort	USA	79 (57♂) with no treatment; mean age=40.7±0.7years; 96.1% African American, 1.3% Hispanic, 2.6% White and 134 (91♂) with treatment; mean age=44.7±0.5years; 94% African American, 3% Hispanic, 3% White	modified Paffenbarger questionnaire	A	Chi-square tests

37	Shah 2005 [45]	Cross-sectional	USA	45♂ all White with a mean age=47.1±8.4years versus 6♀ (5 White, 1 African American) with a mean age=42.5±5.9years	Self-report	A	Wilcoxon rank sum tests and Spearman's correlation coefficients
38	Bopp 2004 [44]	Cross-sectional	USA	66; mean age=39±8.years; 92% African American, 5% White, 3% Hispanic	Accelerometer	C	Pearson correlation coefficients
39	Clingerman 2003 [43]	Cross-sectional	USA	78 (70♂); mean age=40.4±8.3years; 59% African American	PAQ	A	Pearson correlation coefficients
40	Domingo 2003 [42]	Cross-sectional	Spain	75 (56♂) on stavudine with mean age=38.8±8.6years and 75 (62♂) on zidovudine with mean age=39.3±9.5years	MLTPA	A	Kruskal-Wallis test
41	Gavrila 2003 [41]	Cross-sectional	USA	120 (107♂); mean age=43.7±8.0years; 86.7% White, 7.5% Black, 5.8% Hispanic	Self-report	A	Logistic regression models

Table 1. Continued.

Nr	First author / year [Ref nr]	Design	Country	Participants	PA measurement	Quality of PA Measurement	Statistical Analysis
42	Collins 2001 [40]	Cohort	USA	2,864 (1403♂); mean age=38years; 49% White, 33% African American, 13% Hispanic	Self-report regular exercise	A	Logistic regression models
43	Sheehan 2000 [39]	Cohort	UK	33♂; median age=35years; mean BMI=20.8	Doubly labeled water	C	Linear regression models
44	Mustafa 1999 [38]	Cohort	USA	156♂; mean age=35.0±6.4years;	How many times a week do you engage in physical exercise?	A	Cox proportial hazards model
45	Macallan 1995 [37]	Cross-sectional	UK	27♂; median age=35years	Doubly labeled water	C	ANOVA

A=self-report of poor or unknown reliability/validity in persons living with HIV, B=self-report with acceptable reliability/validity in persons living with HIV, c=objective PA assessment, RCT= randomized controlled trial, PA=physical activity, BMI=body mass index, IPAQ= International Physical Activity Questionnaire; MAQ= Modifiable Activity Questionnaire, MLTPA=Minnesota Leisure Time Physical Activity, PAQ=Physical Activity Questionnaire.

Correlates of Physical Activity in People Living with HIV/AIDS

Table 2 summarizes associations between 55 potential correlates and the physical activity participation in people with HIV/AIDS.

Demographic Correlates

For 3 of the 8 demographic variables there was a consistent (reported in 4 or more studies) finding. Older age (6/10 studies; 60%) was consistently associated with lower and a higher educational level with higher physical activity levels (6/7; 86%). Gender differences were inconsistently reported, i.e. while 6 studies indicated men engaged in more physical activity than women, another reported the opposite, while 8 other studies showed no difference between genders. While one study reported a higher physical activity levels in the non-white population, another reported lower levels and 4 studies reported no associations. Being married, having a manual labor versus non-manual labor job and a higher annual income were all in one study significantly associated with a higher physical activity level while only 1 of 2 studies found that having a job was associated with more physical activity.

Biological Correlates

Seventeen biological correlates were included. There was consistent evidence for 4 correlates. Exposure to antiviral therapy (4/6, 67%), a lower number of CD4 cells/µl (7/11, 64%) and the presence of lipodystrophy (4/4, 100%) were all consistently associated with lower levels of physical activity. A potential biological correlate of interest, which across three studies was associated with higher levels of physical activity was a higher cardiorespiratory fitness level. The presence of opportunistic infections was negatively associated with physical activity in 3 studies. The body mass index (3/8; 37.5%) and a higher viral load (4/8; 50%)

were inconsistently associated with physical activity levels. The presence of cardio-metabolic comorbidity is not associated with lower physical activity levels (3/10; 30%). Other biological correlates of interest are summarized in Table 2.

Behavioral Attributes/Skills

Eight behavioral attributes were examined (see Table 2), but due to limited data none were considered consistently related to physical activity. Current alcohol use (1/3; 33%) and illicit drugs (1/5; 20%) use seem not to be associated with current physical activity behavior. The association with adherence to antiviral therapy was inconsistently associated with physical activity levels (1/2; 50%). Findings reported in only one study are presented in Table 2.

Psychological, Cognitive and Emotional Correlates

Twenty correlates were included. No correlate was consistently reported in 4 or more studies. A more positive health attitude was in 3 studies associated with more physical activity, while a higher self-efficacy, more perceived benefits and a better perceived physical functioning and general health were in 2 studies associated with more physical activity. Higher levels of depressive symptoms were in 3 studies, and more perceived bodily pain in 2 studies reported as a negative correlate, i.e. higher levels of depression and more bodily pain are associated with lower physical activity levels. A better emotional functioning was in 3 studies unrelated to the physical activity levels. Details and findings reported in only one study are presented in Table 2.

Social/Cultural Factors

Two of 3 studies (67%) reported on social support as a potential positive correlate.

Environmental Factors

The presence of food insecurity was in Ethiopian men but not in women associated with more physical activity.

Policy Factors

No policy-level correlates were located in the systematic review of the literature.

Table 2. Summary of the Physical Activity Correlates in People Living with HIV

Determinant Variable	Significantly Related to PA		Unrelated to PA	Summary Code°	
	Study*	Assoc.	Study*	Assoc.	% Studies Reporting Assoc.
Demographic Factors					
Age (older)	[78]M [106] [74] [66] [60] [40]	-	[76] [72] [68] [43]	--	60% (6/10)
Gender (female)	[77] [106] [66] [65] [46] [40] / [63]	-/+	[76] [74] [67] [60] [55] [52] [45] [43]	??	43% (6/14 for -)
Race (non-White)	[78]M / [40]	-/+	[76] [68] [47] [43]	0	20% (1/5 for -)
Education (higher)	[78]M [76] [74] [68] [65] [40]	+	[43]	++	86% (6/7)
Marital status (married)	[40]	+		+	100% (1/1)
Employment (yes)	[46]	+	[43]	?	50% (0/1)
Employment (manual labor vs. non-manual)	[74]	+		+	100% (1/1)
Annual income (higher)	[43]	+		+	100% (1/1)
Biological Factors					
Illness duration (longer)			[76] [74] [68]	0	0% (0/3)
AIDS diagnosis (present)	[68]	-		0	0% (0/1)
Exposure to antiviral therapy (yes)	[68] [60] [48] [46]	-	[66] [55]	--	67% (4/6)
Duration antiviral treatment (longer)			[60] [46]	0	0% (0/2)
HIV status (WHO clinical stage higher)	[77]	-		-	100% (1/1)
HIV viral load (higher)	[77] [69]M [44] [43]	-	[76] [68] [61] [46]	??	50% (4/8)
Number of CD4 cells/µl (lower)	[77] [68] [61] [55] [40] [39]M [38]M	-	[76] [74] [44] [43]	--	64% (7/11)
Body mass index (higher)	[78] [77] [72]	-	[80] [76] [74] [68] [57]M	??	37.5% (3/8)
Waist circumference (higher)	[72]		[47]	?	50% (1/2)
Central obesity (present)	[51]	-		-	100% (1/1)
Lipodystrophy (present)	[73] [71] [61] [42]	-		--	100% (4/4)
Wasting (more weight loss)	[37]M	-		-	100% (1/1)
Cardiorespiratory fitness (higher)	[50] [72] [47]	+		+	100% (3/3)
Neurocognitive impairments (more)	[76] [68]	-		-	100% (2/2)
Muscular fitness (higher)			[70]M	0	100% (1/1)
Cardio-metabolic comorbidity (present)	[63]M [59] [49]M		[79] [72] [71] [64] [63]F [48] [47] [45] [42] [41]	0	30% (3/10)
Opportunistic infections (present)	[77] [58] [39]M	-	[68] [40]	-	75% (3/4)

Table 2. Continued.

Determinant Variable	Significantly Related to PA		Unrelated to PA	Summary Code°	
	Study*	Assoc.	Study*	Assoc.	% Studies Reporting Assoc.
Behavioral Attributes /Skills					
Adherence to antiviral therapy (yes)	[62]	+	[53]	?	50% (1/2)
Smoking (more cigarettes per day)	[53]	-		-	100% (1/1)
Smoking history (present)			[74]	0	0% (0/1)
Physical activity history (active)	[65]	+		+	100% (1/1)
Sedentary behavior (more television watching)	[43]	-		-	100% (1/1)
Eating habits (healthier)	[47]	+		+	100% (1/1)
Alcohol abuse (current)	[53]	-	[76] [74]	0	33% (1/3)
Illicit drug use (present)	[53]	-	[76] [68] [46] [40]	0	20% (1/5)
Psychological, Cognitive and Emotional Factors					
Exercise knowledge (present)			[74]	0	0% (0/1)
Self-efficacy (higher)	[74] [65]	+		+	100% (2/2)
Body image (better)	[64]	+		+	100% (1/1)
Health motivation /attitude (higher / better)	[74] [65] [40]	+		+	100% (3/3)
Depression (present)	[69] [68] [53]	-		-	100% (3/3)
Perceived benefits (more)	[74] [53]	+		+	100% (2/2)
Perceived barriers (more)	[74]	-		-	100% (1/1)
Perceived physical functioning (better)	[75] [68] [40]	+		+	100% (3/3)
Perceived physical limitations (more)	[75]	-		-	100% (1/1)
Perceived bodily pain (worse)	[75] [54]	-		-	100% (2/2)
Perceived general health (better)	[75] [43]	+		+	100% (2/2)
Perceived vitality (better)	[75]	+	[44]	?	50% (1/2)
Perceived social functioning (better)	[75]	+		+	100% (1/1)
Perceived emotional functioning (better)			[75] [68] [40]	0	0% (0/3)
Perceived emotional limitations (more)	[75]	-		-	100/ (1/1)
Perceived stress (higher)			[44]	0	0% (0/1)
Perceived appetite (better)	[39]M	+		+	100% (1/1)
Sleep quality (higher)			[44]	0	0% (0/1)
State and trait anxiety (higher)			[44]	0	0% (0/1)
Trans-theoretical model (higher stage)	[56]	+		+	100% (1/1)
Social/Cultural Factors					
Social support (more)	[64] [43]	+	[53]	+	67% (2/3)
Physical Environment					
Food insecurity (present)	[77]M	+	[77]F	?	50% (1/2)

Policy Factors					

PA=physical activity; *Reference numbers; °The percentages in parentheses refer to the number of associations supporting the expected association divided by the total number of associations for the variable. Associations are coded with: "0" (0-33% of studies supporting association); "?" (34%-59% of studies supporting an association); or "+" or "-" (60%-100% of studies supporting an association). When four or more studies support an association or no association, it is coded as "--", or "++" indicating that there is consistent evidence for that correlate. The "??" code indicates a variable that was investigated four or more times studied with considerable lack of consistency in the findings. M=only valid for men, F=only valid for women, SDT= self-determination theory.

Differences in Number of Significant Correlates

Fisher's exact tests showed there were no differences between un-validated and validated self-report instruments (P=0.49) or between self-report and objective tools (P=0.81). In contrast, significantly (P=0.007) more correlates and less unrelated variables were obtained in studies with a sample size equal to or larger than the median sample size.

Discussion

General Findings

To the best of the authors' knowledge, the present review is the first to systematically document the correlates of physical activity in persons with HIV/AIDS. Out of 55 correlates from 45 studies, 5 consistent (i.e. reported in 4 or more studies and consistently associated in at least 60% of the cases) correlates were obtained. Lower levels of physical activity were consistently associated with older age, a lower number of CD4 cells/µl, exposure to antiviral therapy and the presence of lipodystrophy while higher levels were found in those with a higher educational level. One should take into account that several of these correlates may be interrelated with each other. For example, the presence of lipodystrophy is a known side-effect of exposure to antiviral therapy (stavudine which the World Health Organization recommends to be phased out due to its side-effects such as lipodystrophy [81]), and the number of CD4 cells/µl is also associated with exposure to antiviral therapy.

For gender, the body mass index and HIV viral load, findings were consistently conflicting. We believe that the limited number of consistent correlates observed in the present review might be due to differences in study design, sample characteristics, choice of assessments/correlates, statistical analyses, and differences in sample sizes. More significant correlates were obtained in studies with a sample size equal to or larger than the median sample size. Nevertheless, although there was a large heterogeneity, our varied findings clearly illustrate that participation in physical activity by people living with HIV/AIDS is associated with a range of complex factors.

Knowledge about demographic correlates of physical activity behavior will help to identify these high-risk persons in whom physical activity is low or, even, likely to be reduced and who may require intensified and targeted interventions. The current review shows that older patients with HIV/AIDS, those with a lower educational level and those on antiviral therapy are the most vulnerable patients in need for intensified care. The observation that older age was associated with a lower physical activity participation is in agreement with findings in the general population [36] and seems not to be due to a longer illness duration which was in none of 3 studies a significant correlate. Special attention should also be given to people with lipodystrophy. There are several pathways through which the presence of lipodystrophy might be a barrier to adopt and maintain an active lifestyle. Its presence has important psychological effects, ranging from bodily discomfort to low self-esteem and depression [82]. The observation in one study [64] that a better body image in people living with HIV/AIDS is associated with higher physical activity levels might confirm this hypothesis. Owing to its physical manifestations, lipodystrophy is viewed as a visible marker of the HIV disease as well which might on its turn cause stigmatization and social isolation [83]. Patients and healthcare professionals should be informed that positive experiences when being physically active can improve the physical comfort and body satisfaction of people living with HIV/AIDS [84]. This finding is also relevant in resource-limited areas of sub-Saharan Africa [85]. Researchers and clinicians should explore in more detail what techniques can stimulate these positive experiences in people with HIV/AIDS who are confronted with lipodystrophy.

The fact that immunological parameters such as a lower number of CD4 cells/µl are associated with less physical activity might be due to the fact that this a measure for the disease severity and the need for treatment and might be associated with symptoms as nausea [86], depression [87] and pain [88]. Two different studies indicated that respectively the presence of depression and bodily pain are negatively associated with physical activity among people with people with HIV/AIDS, a finding which has been observed in vulnerable mental health populations as well [34, 89]. A systematic review of 61 studies in people living with HIV/AIDS demonstrated that the prevalence of pain ranged from a point prevalence of 54% (95%CI=51%–56%) to 83% (95%CI=76%–88%) using a three-month recall period [88]. The types of pain experienced by people with HIV/AIDS and the aetiology appear to vary. As indicated, people living with HIV/AIDS may experience pain as a direct result of the virus on the peripheral or central nervous systems. Pain may be due to resultant opportunistic infections as well, which was reported as a negative correlate in 3 of 4 studies, or pain may arise as a result of the side effects of anti-retroviral treatment [88] [90]. Despite an increasing awareness of pain as a significant contributor to the disability and impaired health related quality of life, the problem of its under-management persists [88]. Although there is preliminary evidence [91, 92] that inclusion of physiotherapy as a complementary treatment for pain-management and simultaneously improving mental and physical health outcomes and reducing disability is promising, also in in resource-limited areas of sub-Saharan Africa [93], more research is needed.

Our data suggest that higher cardiorespiratory fitness is positively associated with physical activity, an observation made in the general population as well [36]. Therefore, physiotherapy should focus on cardiorespiratory fitness parameters. Cardiorespiratory fitness is the ability of the circulatory and respiratory systems to supply oxygen to working muscles during sustained physical activity [12] and is a strong and independent predictor of disability and all-cause mortality [94]. Research in a disadvantaged setting in South-Africa demonstrated that exercise might improve cardiorespiratory fitness, although follow-up is needed [95].

Finally, our data show that more research regarding the association between higher HIV loads and physical activity participation is needed. Until clear clinical practice guidelines become available, patients with high HIV viral load levels should be recommended to perform moderate instead of high intensity physical activity. While moderate intensity physical activity improves the immune function in people with HIV/AIDS [96, 97], high-intensity exercise is known to have immunosuppressive effects in the general population [98, 99] and in people living with HIV/AIDS [100].

Limitations and Recommendations for Future Research

There are several limitations to this review, which should be acknowledged.

First of all, the diversity of physical activity measures prevented us from performing a formal meta-analysis. Self-report questionnaires are, for example, known to require motivation to complete all of the questions and often the detail regarding the level (frequency, duration and intensity) and type of physical activity is not consistently evaluated. To the best of our knowledge only the International Physical Activity Questionnaire [101] and the Baecke Physical Activity Questionnaire [50] have been validated in people with HIV/AIDS. Fewer significant associations would be expected in studies that relied on un-validated self-report measures and in self-report versus objective assessments. However, Fisher’s exact tests showed there were no differences between un-validated and validated self-report instruments or between self-report and objective tools. Considering the wide diversity in physical activity assessments, our findings do reveal that there is a high need for researchers to adopt a clear consensus on which assessment tools should be recommended in people living with HIV/AIDS.

Second, all correlates investigated were only documented in a small number of studies. Examination of the same, standardized variables in different studies is necessary in order to build a consistent body of evidence that can support or refute the potential influence of individual variables.

Third, the majority of the studies investigated physical activity correlates at only one level of the socio-ecological model, with very limited data about the potential role of social and environmental variables and no studies on policy factors. Future studies should attempt to analyze the role of multiple correlates of physical activity from a broad socio-ecological perspective. Given that research suggests that maintaining changes in physical activity requires a multilevel approach [20], exploring these interactions in people living with HIV/AIDS is highly important. At the social level of the socio-ecological model, future research could focus on the amount and type of social support necessary to begin and maintain physical activity behavior in people living with HIV/AIDS. This kind of research could explore whether: (a) the relationship between physical activity participation and professional support is a dynamic process in which the sources of support or need for support change over time, and (b) any social barriers for people living with HIV/AIDS can be identified and addressed by involving significant others in the rehabilitation process. Data on the role of social support in facilitating physical activity behavior in people living with HIV/AIDS are currently inconsistent. At the environmental level of the socio-ecological model, the role of the built environment on a person’s physical activity behavior should be evaluated. Built environments are the totality of places built or designed, including buildings, grounds around buildings, layout of communities, transportation infrastructure and parks and trails [102]. There are self-report tools available for assessing the built environment [103], which have been used in sub-Saharan

African countries where the majority of people with HIV/AIDS live [104]. Correlates at the policy level of the socio-ecological model are likely to be best initially explored using a qualitative approach [31]. Researchers should examine, which policies are currently in place to motivate people living with HIV/AIDS to engage in an active and healthy lifestyle. Interviews of people living with HIV/AIDS but also healthcare professionals and policy makers may provide further insight as to what is needed to stimulate an active lifestyle. If the purpose is to inform and motivate policy changes that will improve the quality of life and reduce the disability in people living with HIV/AIDS merely documenting the relationship between for example environmental changes and physical activity behavior is likely to be insufficient. At some point, environmental and policy change research will need to include assessments of broader health outcomes in people living with HIV/AIDS, such as changes in the prevalence of chronic co-morbidities, health care service utilization, as well as the economic costs and benefits of proposed policy changes.

Fourth, while the majority of people with HIV/AIDS live in Sub-Saharan Africa [1], only a limited number of studies in this review (5/45) were executed in this region. This lack of studies from Sub-Saharan African countries highlights the gap between where most research is done and where the largest public health impacts of physical inactivity for people with HIV/AIDS are probably located. The effect of HIV/AIDS on African people has larger consequences because if their productivity is affected, this directly affects family welfare and increases the scale of both family and community poverty. In Sub-Saharan Africa, many HIV patients are relying on labor-demanding jobs in the informal sector with no job security or compensation for lost income. Maintaining physical strength and an adequate activity level is thus of crucial importance for their livelihoods [105]. Therefore, there is a high need for exploring in particular physical activity participation correlates in Sub-Saharan Africa. Future physical activity research in Sub-Sahara Africa should for example focus on the socio-cultural context in which people with HIV/AIDS are physically active and which is often different than in Western countries. For instance, in most Sub-Saharan African countries, if women are thin, they may be stigmatized for being poor or for having HIV [106]. Such prejudices might prevent women from being physically active as they are afraid of losing weight. Finally, future studies in Sub-Sahara Africa would benefit from assessing to what extent the lack of a comprehensive health policy in most of these countries and specific environmental factors such as lack access to physical activity related treatment and recreation facilities, unsafety due to crime or dangerous traffic in urban settings, food insecurity, civil conflicts, and extreme weather conditions are all linked to physical inactivity in people with HIV/AIDS.

Fifth, the finding that people taking antiviral therapy may have lower levels of physical activity is of interest and perhaps differs from expert opinion and anecdotal clinical observations. More research is required to confirm or refute this finding and explore why this relationship may have been observed.

In conclusion, our results demonstrate that participation in physical activity by people with HIV/AIDS is determined by a range of complex factors. Special attention should be given to older patients, those with a lower educational level, those presenting with lipodystropy and those on antiviral therapy. We recommend that health care professionals, and in particular physiotherapists, should also consider the presence of pain and depression when encouraging people with HIV/AIDS to engage in physical activity. This will be particularly pertinent given that previous literature has demonstrated the positive effects of physical activity on the physical and mental health comorbidities seen more recently in this group.

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Conflict of Interests

All authors declare that they have no conflicts of interest relevant to the content of this review.

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